group of animals must be an instinct, since it could not be acquired through individual experience. But how if the conditions of acquisition are also common to the whole group? Thus an infant certainly learns to scratch itself; since, however it may itch, some considerable experience is necessary before it learns to localise the sensation. As, however, the conditions of this acquisition are common to all children, all learn to scratch themselves. Now in many animals this is an inherited acquisition; they scratch themselves from the first. Whether the infant also inherits a structure which would develop into one as apt as that of the animal, cannot be ascertained; all we know is that the infant's nervous structure is too immature at first to permit the localisation of sensation. How much of the subsequent aptitude is the result of congenital tendency, and how much of acquisition through incidental experiences acting on a predisposed organism, cannot be estimated.*

That we require some character to distinguish the instinctive from the impulsive actions, may be readily shown. No one calls Breathing, Secretion, Excretion, &c., instincts. Yet these are the actions of congenital tendencies in the organism. "A hungry chick," says Mr. Spalding, "that never tasted food, is able on seeing a fly or spider for the first time, to bring into action muscles that never were so exercised before, and to perform a series of delicately adjusted movements that end in the capture of the insect." Every one would pronounce this a typical case of Instinct. Now compare with it the following, which no one would class among the instincts: A new-born animal that has never breathed before is able on first feeling the stimulus of the atmosphere to bring into action a very complicated group of muscles which never were so exercised before, and to perform a series of delicately adjusted movements which end in the aëration and circulation of the blood.

This contrast may lead us to the character sought. Understanding that every line of demarcation in psychical phenomena must be more or less arbitrary, and only justified by its convenience, we may draw such a line between Impulse and Instinct. Impulses are the actions which from the first were fatal, inevitable, being simply the direct reflex of the stimulated organs. Given the respiratory organs and the atmosphere, Respiration is the inevitable result. Given the secretory organ and the plasma, Secretion is the inevitable result. There is no choice, the action either takes place or it does not.

Instincts *are* also fatal, inevitable, but they *were* not always so; the element of choice intervenes; and although the intelligent discrimination may be *almost* entirely lapsed, it never is wholly lapsed. The guiding sensation is still discriminative, selective. Hence instincts vary with varying conditions. Thus the *nutritive impulse* which when unsatisfied causes the uneasiness of desire, and which moves the animal in search of food, is markedly distinguishable from the *instinct* which selects the appropriate food and rejects all the rest. If an animal eats only certain kinds of food, out of many which would be nutritious, it is because these kinds have been selected by it, or by its ancestors. Every chicken, Mr. Spalding assures us, has to learn not to eat its own excrement. "They made this mistake invariably, but they did not repeat it oftener than once or twice." He also has this remark:—"Chickens, as soon as they are able to walk, will follow any moving object; and when guided by sight alone they seem to have no more disposition to follow a hen than to follow a duck or a human being. Unreflecting onlookers when they saw chickens a day old running after me, and older ones following me miles and answering my whistle, imagined that I must have some occult power over the creatures, whereas I simply allowed them to follow me from the first. There is the instinct to follow; and, as we have seen, their ear, prior to experience, attaches them to the right object."

I should rather say, "there is the *impulse to follow:* and the instinct to follow the mother, or a duck, or the master who feeds them, is the selected action which becomes rapidly an organised habit." It is one of the conclusions of my work that all our involuntary and automatic actions, were originally voluntary, and that all instinctive actions were originally intelligent. In the case now under consideration, the impulse to follow is a fixed tendency; the instinct to follow is facultative at first, and becomes fixed by habit, but is always, even when most firmly fixed, guided by discriminating feeling.

To conclude: where there is no alternative open to an action it is impulsive; where there is, or originally was, an alternative, the action is instinctive; where there are alternatives which may still determine the action, and the choice is free, we call the action intelligent.

GEORGE HENRY LEWES

HANDBOOK FOR THE PHYSIOLOGICAL LABORATORY

Handbook for the Physiological Laboratory. By E. Klein, M.D.; J. B. Sanderson, F.R.S.; M. Foster, F.R.S.; and T. L. Brunton, M.D., D.Sc. (Churchill.)

STUDENTS of chemistry have, for a long time, by means of the works of Fresenius and others, had the opportunity, almost unaided, of verifying for themselves most of the experimental results of which they hear in lectures, and read in text-books; and thus many are able, before they have finished their educational course, to obtain a thorough practical knowledge of the science. Such has not been the case with regard to physiology; the subject is less advanced, and has progressed more slowly; perhaps this is because the descriptions of the methods by which the ends have been arrived at, as given by lecturers and writers, are incomplete and insufficient. The work before us is the first important attempt that has been made to put the commencing physiologist in a fair position to begin original work on the subject, by giving him the necessary directions for himself performing many of the fundamental experiments on which the science is based. Whether physiology in its most comprehensive sense, as understood by the authors of this work in their title, is a single branch of science which can be thus treated in its unity, or whether it ought to be divided up and incorporated with others already established, is a point which has not yet been satisfactorily settled, and which the perusal of this book may assist in proving.

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* The examples of dogs and horses finding their way home, however marvellous, cannot be affiliated on Instinct, since it is very far from common to the species: for one dog who finds his way home, hundreds are helpless when lost.

The work is in two volumes, the first, much the larger, being devoted to the text, while the second contains the drawings of the microscopical preparations described, as well as the instruments, diagrams, and dissections referred to.

The histological section, written by Dr. Klein, is, as a whole, far superior to any existing work on the subject, which is saying a great deal, considering the large number of treatises on the use of the microscope, in the study of the tissues of the animal body, which have already appeared. The careful way in which all the many details receive their due consideration, is an example to authors of text-books, and it is rendered evident on every page that the author is himself thoroughly familiar personally with the points he records. Many methods till now comparatively little known and employed in this country are fully discussed, among the most important of which is that of injecting organs by the "method of puncture," introduced by Ludwig, which though it in many cases gives very decided results, has to be used with caution, as their interpretation is often far from easy and sometimes misleading. The minutest details, the omission of which so often mars the results are given in many cases as well as if the teacher himself were by the side of his pupil. The means to be employed for obtaining a view of the stomata of the lymphatic system, as they are seen on the centrum tendineum of the diaphragm, is a case in point to which several pages are devoted, in which also the structure of these little understood organs is excellently entered into. The chapter on embryology is also very complete; the paragraphs on striated muscular fibre are as logical as they are clear, the following being the summary:—" From all these (the previous) facts we learn that the substance of a muscular fibre consists, in the first place, of oblong prisms, *i.e.*, sarcous elements, with their axes parallel to its axes, and formed of a material which refracts light strongly, is stained strongly with silver, slightly with solution of chloride of gold, and swells out in the fresh state on the addition of water; and secondly, of a less refractive transparent interstitial substance occupying the remainder of the space, which is not coloured by silver, but is intensely stained by chloride of gold, and disappears in dilute acetic acid." The illustrations accompanying the descriptions are new, and on a sufficiently large scale to render quite apparent the minutest structural points; much may be learnt from a simple inspection of them. We do not quite like the introduction of so many German synonyms for many of the terms employed, they convey but little meaning to most English students, and though otherwise harmless, they might be taken to indicate that our language is poor in mechanism, or that we are overpoweringly indebted to our worthy relations, neither of which views is strictly correct. A little consideration might have been shown to our microscope makers by the employment of the well-known English nomenclature of objectives (for a man may be a first-class histologist and yet not know the meaning of Hartnack's No. 10), and the systematic ignoring of their excellent workmanship cannot but produce ill-feeling; for though they may be expensive, they have undoubtedly been the originators of most of the greatest improvements in their branch.

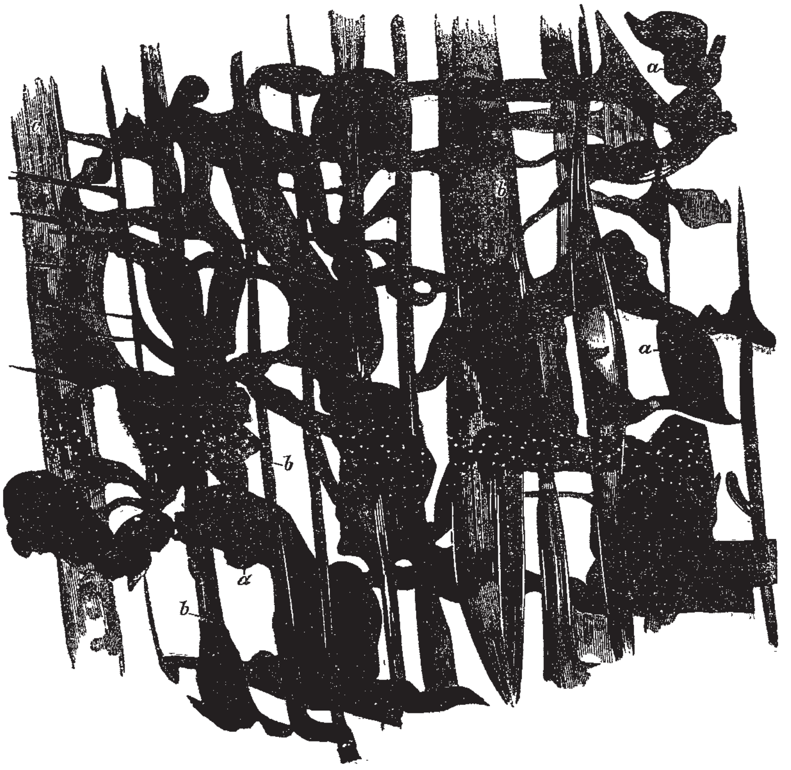

FIG. 1.—Centrum tendineum of rabbit, seen from the abdominal side. Berlin blue had been introduced into the peritoneum by "natural injection." *b*, Straight interfascicular lymphatics between the bundles of tendon of the abdominal side; *a*, lymph vessels of the pleural side, showing the valves, with corresponding dilatations. The last lymph vessels are as completely injected as the first. (Oc., 3 : Obj., 4. Tube not drawn out.)

Dr. Sanderson has undertaken the physiology of the blood, together with that of the circulation, respiration, and animal heat. The chapter on the first of these subjects is excellent and thorough, nothing better could be wanted, the author being able to keep within the region of fact. The German elaborate verifications of the supposed functions of many of the most important nerves, are given in a very lucid and concise manner, and several of the excellent instruments introduced by them are clearly described, together with the principles of their action, and the methods of employing them. But in the other more theoretical subjects, there are many statements to which we must take exception. Most of the theories bearing on some of the main problems in the circulation of the blood, are at the present day in too unsettled a state to find a place in a manual for students, because it is impossible in the permissible space to give the many conflicting results of different authors, which yet remain unproved or unrefuted. The result is, as might be expected, that a one-sided and individual view of the subject is presented, and the student is taught some things which he will have to unlearn. Most of Dr. Sanderson's theories have already appeared, but nevertheless some are based on principles undoubtedly unsound.

Whilst discussing the expansive movements which occur in an artery during the different parts of the pulse beat, and the cause of the variations in the extent of the changes in diameter of the arteries which may be observed, the following occurs :—"A moment's consideration teaches us that there are two circumstances which must diminish the minimum pressure in the arteries, viz., diminution of the mean arterial pressure, and prolongation of the period which intervenes between one expansive act and its successor. In other words, *the less frequent the contractions of the heart and the lower the arterial pressure, the greater the expansion in proportion to the expanding force which produces it*" (the italics are not ours). Dr. Sanderson would undoubtedly thus lead us to believe that this is a self-evident proposition, but that it is so is far from the case. That it should be true it has to be assumed that the escape of blood from the peripheral vessels *between two succeeding pulse beats*, depends on the interval which elapses between them, and no attempt is made to prove this fact, which is not at all necessarily correct, and against which many arguments can be adduced. The same author also adopts a modification of the now antiquated and decidedly insufficient oscillatory hypothesis, to account for the dicrotic beat of the pulse, so clearly seen in the sphygmograph trace: and in so doing he necessarily ignores the great value of the important and very definite results obtained by Chauveau and Lortet, by means of their hæmadromograph ; if he had fully realised the easily demonstrable fact that the second rise in the sphygmograph trace *commences* the later in an artery according as it is farther from the heart, the table on p. 228 referring to the relations of the different elements of the pulse beat in different vessels could not have appeared in its present form. As long as physiologists compare arteries to elastic tubes in air, they must be led into error, for the forces which predominate in them so situated, are very different from those which prevail when they are surrounded by water or any yielding substance, which an artery much more directly resembles, as it is surrounded by, and on most sides in contact with, tissues of a somewhat yielding nature. There is another short sentence we must quote ; in explaining the action of the auriculo-ventricular valve we read : "The time which intervenes between the commencement of the compression and the tightening of the valve varies according to the vigour of the contractions, the quantity of the blood contained in the ventricle, and the previous position of the valve, must always be appreciable." Does the author really wish us to believe that the heart, a powerful muscular pump, which he affirms (though on very slight grounds) acts most powerfully at the commencement of each beat, requires an appreciable time, by which we understand, one that can be measured by instruments at our command, to tighten the auriculo-ventricular valve, against which the resistance is undoubtedly extremely small ? it seems very improbable.

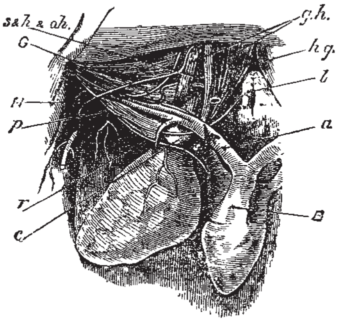

FIG. 2 —Dissection of the parts in relation with the vagus nerve of the frog on the right side. The oesophagus is distended with a glass tube about half-an-inch in width. The object is represented of about twice its actual size *a*, right aorta ; B, *bulbus aortæ* · *c*, posterior horn of the hyoid bone : *g h*, genio-hyoid muscle ; *h g*, hyo-glossus muscle ; *p*, lowest of the three petrohoid muscles ; H, ninth nerve ; G, glossopharyngeal nerve ; *r*, vagus ; *b*, larynx ; *s* & *h* & *o h*. point to the space occupied by the origins of the large muscle (sternohyoid) which connects the hyoid with the sternum, as well as by the omohyoid ; both of these muscles have been cut away.

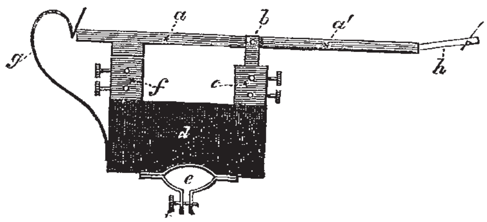

FIG. 3.—The marking lever for indicating graphically on a revolving drum the moment at which an electric current is broken.

The chapter on animal heat contains much useful information, but several of Senator's results are not entered into, and Laschkewitsch's explanation of the fall of temperature in "varnished" rabbits, which are discussed in detail, is not given. None of the special precautions which have to be taken in employing the mercurial thermometer for physiological investigation, are referred to ; and the student will be entirely misled respecting the principle upon which the ordinary clinical thermometer of Phillips is constructed, the author having muddled up with his description Hawksley's method for preventing the index running into the bulb whilst the operator is depressing it, which is entirely independent of, and has nothing to do with, the self-registering power of the instrument. A similar want of knowledge of physics is shown on the same page on which this error occurs, for it is stated that in the thermometric couple the degree of deflection of the galvanometer needle, which is produced when a current results from the unequal heating of its ends, varies with the difference of the temperature of the junctions, which is well known to be incorrect.

Dr. Foster, in undertaking the "Functions of Muscle and Nerve," has undoubtedly had a difficult work to perform, and he has introduced a very clear and simple method of teaching the various, and in many cases, disconnected facts which relate to them. The student will, in this section of the work, find full directions for performing most of the experiments, which will, when all repeated, enable him to advance on a thorough and sound foundation. Great care is taken to render evident the phenomena of electrotonus, and the subject of tetanus is dwelt on in detail, the following being the propositions which are discussed and proved regarding it:—1. "Tetanus from an ordinary interrupted current is a continuous contraction rapidly reaching a maximum, continuing (within limits) in that condition so long as the current is passing, and followed by a gradual relaxation upon the current being cut off." 2. "Tetanus really consists of a series of simple muscular contractions fused together." The apparatus necessary for verifying these and other points in which electricity plays a part, is described as far as is necessary for the wants of the physiological student, and some, as Wippe's double key and Du Bois Reymond's rheocord, are figured. Several of the points insisted on appear to be insignificant in themselves, but they must all, in the long run, have important bearings on future theory.

In undertaking the "Physiological Chemistry," Dr. Brunton has had a somewhat easier task than the two authors last referred to, and his work is excellent. The results of Hoppe-Seyler, and other German chemists, which are as convincing as they are connected, are fully entered into, and the chemistry of digestion and excretion, together with the method of arriving at them, are explained at considerable length. As an instance of the manner in which the subject is handled, the following are the propositions which are demonstrated in connection with the fact that pepsin is not destroyed during digestion. 1. "Although the digestive power of pepsin appears to be indefinite, yet a limited quantity of gastric juice will not dissolve an unlimited quantity of fibrin." 2. "The arrest of digestion in this experiment (the proof of the previous proposition) is not due to the destruction of pepsin, but to the accumulation of the products of digestion in the liquid and to the want of acid." 3. "A stronger acid is required for digestion if the products of digestion are present in quantity in the solution." The theory of digestion, together with the action of the vagus and splanchnics on the stomach are fully discussed, and the unassuming way in which the author states his own opinions carries great weight with it.

We should have liked to have seen a separate chapter on the methods to be used for rendering animals insensible, together with a notice of the relative value of different anæsthetics and the way to exhibit them; as it is, the subject is only incidentally mentioned in connection with special operations. If the drawings of the instruments had been incorporated in the text they would have been more easily referred to, and therefore more frequently looked at; as it is, the one volume without the other is difficult to understand. The anatomical sketches, mostly after Bernard, which illustrate the distribution and relations of the nerves and vessels that so frequently have to be manipulated by operating students, adds much to the completeness of the work, in which every effort has evidently been made to put the student in as good a position with regard to the subject as can be desired.

The three accompanying woodcuts are from the second volume of this work. The largest is an example of the size and character of the excellent illustrations in Dr. Klein's histological section. Dr. Sanderson contributes that illustrating the relations of the pneumogastric nerve in the frog, and the third is one of the several electrical instruments described by Dr. Foster.

WILSON'S INORGANIC CHEMISTRY·

Inorganic Chemistry. By the late George Wilson. M.D., F.R.S.E. Revised and enlarged by H. G. Madan, M.A. (London and Edinburgh: W. and R. Chambers.)

LIKE so many of our old friends among the best books on chemistry, the present edition of the late Prof. Wilson's Inorganic Chemistry has undergone somewhat extensive alterations, and received considerable additions, which, in the opinion of its able editor, have been rendered necessary by the recent progress of chemistry. The original plan, which is that adopted in some of our best text-books, has been adhered to, viz. of introducing the student to a knowledge of the more important fundamental laws of chemistry, and to make him familiar with the properties of the chief elementary substances, and their more remarkable compounds. What is generally known by the name of chemical physics occupies about one-fourth of the whole book. This portion is clear and concise, and deserves the highest eulogium. It may be perused with advantage by every chemical student. The theory of atomicity of elements, which is fast giving a new impression to organic chemistry, and which by some of our most eminent chemical teachers has of late been introduced into the domain of inorganic chemistry also, and which promises to reconcile and harmonise both branches of chemical science, has received but scanty recognition at the hands of the editor, although he professes to have brought the chemical nomenclature (in deference to the wishes of the publisher), into accordance with the system adopted by Profs. Frankland and Williamson.

Professor Wilson seems to have felt that physical and chemical laws cannot be studied with advantage without having some physical and chemical facts to work upon, and the pupil is therefore recommended to read the first 108 pages, treating of chemical physics, with some care before proceeding further; but "he is not to expect to understand the introductory portion at once, but must go back from time to time to their study, when he will find them more and more intelligible as he grows familiar with the properties of chemical substances," explained in the later pages. Is not this an admission that the plan upon which the book is constructed is a faulty one? Is it not time to relegate chemical physics to physics proper, especially when we have such excellent elementary text-books as Balfour Stewart's and others, and to treat of chemical changes in chemical text-books? Not that we would have it inferred that chemical changes can be understood without a knowledge of the general properties of matter, of heat, light, and electricity. By far the greater number of chemical changes being dependent upon chemical affinity, the laws of chemical combining proportions and volume composition can very well be explained by confining the teaching at first mainly to chemical changes. Physical considerations, especially at